Evaluating the longer term benefits of sustainable drainage

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Sustainable drainage systems (SuDS) can bring a wide range of benefits in addition to reductions in flood risk. However, there is limited quantified evidence of the value of these benefits. To help address this, the Construction Industry Research and Information Association led a project to develop the Benefits of SuDS Tool (Best). The approach presented in this paper shows how scenario planning can be used in Best to evaluate longer term benefits in the face of future uncertainty. Three case studies are presented, showing how this can inform robust decisions and the selection of SuDS options for maximum value.

1. Introduction

In addition to ensuring primary functionality, maximising overall value is an important goal in infrastructure design. Until recently, accounting procedures have struggled to allow effective inclusion of broader environmental and social impacts (e.g. Obst *et al.*, 2016). The millennium ecosystem assessment (MEA) provides a broad set of internationally agreed defined benefits from ecosystem services (ESS) (e.g. Sukhdev *et al.*, 2010). Monetisation of individual ESS components to demonstrate value is changing the way in which infrastructure options are selected.

In managing urban area drainage, ‘burying the problem’ of surface water is gradually being replaced by an approach that utilises the opportunities provided by rainfall where it lands (Woods Ballard *et al.*, 2015). What was formerly seen as ‘sustainable development’ (e.g. Allen *et al.*, 2016) is aligning to the ‘circular economy’ – a subtle shift that puts economics at the heart of the decision process (e.g. EEA, 2016). This reflects an increasing need for the impacts of decisions to be explicit and for investments to deliver value for money.

Sustainable drainage systems (SuDS) comprise a range of measures, as defined in the Construction Industry Research and Information Association (Ciria) ‘SuDS manual’ (Woods Ballard *et al.*, 2015), that provide a wide range of benefits (Figure 1). Traditional piped drainage systems and many below-ground SuDS deal with the quantity and, to some extent, the quality aspects of stormwater runoff, but provide no added benefits. The benefits from SuDS include those illustrated in Table 1 (see also Jayasooriya and Ng, 2014). Many of these benefits can be understood from the MEA ESS

accounting guidance and other guidance for social or health benefit accounting, as explained by Social Value UK (2012) and WHO (2016), respectively.

A number of tools and procedures can assess the wider benefits of SuDS, but few provide a monetised result. Hoang *et al.* (2016) develop a means to assess ‘spatially distributed benefits intensity’, which is considered to be context and location specific. In the USA, the Center for Neighborhood Technology (CNT, 2010) monetisation tool is used for SuDS (termed green infrastructure (Fletcher *et al.*, 2015)) while, in the Netherlands, the Teeb urban tool has been developed for valuing blue-green infrastructure (BGI) (Van Dijk *et al.*, 2013).

In a UK project managed by Ciria, the freely available tool Best (Benefits of SuDS Tool) was developed for valuing the benefits of SuDS (Ciria, 2016). Best is now being used for scenario planning, following a similar approach as used for flood and coastal erosion risk management in the UK (Brisley *et al.*, 2015).

The traditional approach to evaluate the effectiveness of design options usually considers the status quo (i.e. current environmental and societal factors) and then provides an allowance for future changes, such as factoring rainfall by some 30% and increasing paved areas from development plans with an allowance for urban creep. In Best, this approach is termed ‘business-as-usual’ (BaU). By selecting one value for rainfall uplifts and another for increases in drained areas, BaU assumes a single version of what the future will be like (the BaU scenario). The third edition of Best Ciria (2016) includes

Figure 1. Illustration of a blue–green SuDS system in Dundee, Scotland (Photograph Richard Ashley)

the means to evaluate benefits under multiple scenarios (visions of future states) in addition to BaU.

This paper presents findings from the use of Best for two case studies in the UK and one in the Netherlands. These are used to show how the individual benefits vary between options and over time and to highlight the importance of considering the longer term in assessing the financial and other benefits of SuDS, especially for planning for adaptability and flexibility when managing system resilience. There are important questions regarding how to reconcile the value to the main beneficiaries from the use of SuDS and BGI with those who fund these systems now and in the future, and also how to get the most value from SuDS and avoid the ‘market failure’ of not exploiting them (Ciwem, 2017).

2. The benefits of blue and green SuDS

SuDS comprise a range of features and invariably include sections of piped drainage. Of the many benefits that SuDS can

potentially provide (e.g. Table 1), certain measures will be more effective than others at providing the benefits, which are time and context dependent. For example, where SuDS replace existing blue or green spaces, the relative magnitude of any added benefits will be significantly less than in situations where SuDS replace paved areas (e.g. Hoang *et al.*, 2016; Ossa-Moreno *et al.*, 2017). In addition, not all ‘SuDS’ are the same when considering their potential benefits. Certain SuDS are comprised entirely of BGI, but may have inlet and outlet features using pipes and concrete. Other SuDS do not include blue or green measures. The case studies presented in this paper are for SuDS that utilise BGI.

The development of Best included a review of existing valuation tools and over 500 monetary values from more than 100 valuation studies of potential relevance to SuDS in the UK (Ciria, 2013). While many of these studies and values were not appropriate for inclusion, the review produced a dataset of relevant and potentially transferable values covering each benefit category and a variety of different contexts (Ciria, 2015). The approach to assessing the benefits uses an impact pathway approach (Defra, 2011), which links SuDS components to impacts on human welfare, as illustrated in Figure 2 for air quality. Monetary valuation of benefits in Best is based on a range of market and non-market approaches using available evidence, including the value transfer approach in UK flood and coastal erosion risk management assessments (Eftec, 2009). Table 1 shows the valuation approaches used for each of the benefit categories in Best (Ciria, 2013). Details of the way in which each of the benefits is assessed in monetary or qualitative terms are given in technical guidance for the tool (Ciria, 2016).

3. Case study examples using Best

Experience from applying Best to three case studies is used to illustrate the implications of valuing the benefits. An outline of the proposed developments in Roundhay Park (Leeds, UK), Killingworth and Long Benton (Northumbria, UK) and

Table 1. Benefits and outline of the approach used for their valuation in Best

Benefit category	Valuation approach	Units
Air quality	Damage cost	£/t pollutant
Amenity	Value transfer (hedonic)	Percentage house price change
Biodiversity and ecology	Value transfer	£/ha
Building temperature	Long-run variable cost	£ energy saved
Carbon reduction and sequestration	Marginal abatement cost	£/t
Education	Avoided investment	£/school trip
Flood risk reduction	Damage cost	£/property
Groundwater recharge	Avoided abstraction cost	£/m ³
Health	Avoided health costs	£/person
Pumping wastewater	Long-run variable cost	£ energy saved
Rainwater harvesting	Avoided investment	£/m ³
Recreation	Value transfer (travel cost)	£/visit
Treating wastewater	Avoided treatment cost	£/m ³
Water quality	Value transfer (stated preference)	£/km

Figure 2. Illustration of the impact pathway approach for air quality and impact on health

Dordrecht (the Netherlands) are set out in Table 2, together with the options considered for each case. In each case, flood risk reduction is either the main objective or a significant consideration. However, each case has unique considerations, including the periods of analysis and start and end dates for their functioning. This paper only sets out to illustrate aspects of benefit valuation using Best and therefore does not show all of the results for Best analytical processes for every case study. Details of the analyses of the two UK cases studies are given elsewhere (Ciria, 2017). The full results of the Dordrecht case

study will be published once the analysis comparing Best with Teeb is complete.

3.1 Results under traditional BaU analysis

Figure 3 shows a comparison of costs and benefits for BaU evaluated using Best for the four options considered for the Roundhay Park case study (as summarised in Table 2) for the client-defined period 2015–2095. The use of conventional tanks (option 1) reduces combined sewer overflow (CSO) spills but offers no other benefits. Option 2 (tanks plus additional

Table 2. Characteristics of Best case studies

Catchment information	Primary objective of the scheme	Options considered
Roundhay Park, UK This catchment has current water quality problems from the CSOs and also periodic flooding including of properties. Population 4700; 46 ha contributing area. Mixed dense and open urban and existing park areas	To improve habitats for white-clawed crayfish	1. CSO tanks 2. As above with additional storage 3. SuDS in public spaces 4. SuDS in public and private spaces
Killingworth and Long Benton, UK The catchment has periodic flooding problems even with relatively modest rainfall events. 20 400 properties, with a population of 39 600 and a contributing area of 1500 ha. The catchment is semi-rural and there is a lot of space for potential SuDS	To reduce flood risks	1. SuDS to provide attenuation and surface water conveyance with exceedance storage 2. As above plus flood protection for an additional 749 properties
Dordrecht, the Netherlands Area 135 ha, with 4 ha (3%) of open water and 40 ha (30%) of paved area, drained by a combined sewer system. Flooding is a risk for short return period events of around 10 years	Urban regeneration to improve liveability	Plan is to fit 5000 m ² of new green–blue area with 260 new trees at the same time as regenerating urban neighbourhoods

Figure 3. BaU results from Best for the Roundhay Park case study for each option considered

flood measures) provides similar levels of water quality and flood risk reduction performance as options 3 and 4, but fewer benefits, with a performance that meets the required standard for numbers and volumes of CSO spills and flooding, similarly to that provided by SuDS in public areas (option 3) or SuDS in public and private areas (option 4). Both options 3 and 4 create a second surface-based drainage network and bring wider benefits, but add costs. However, to deliver and sustain the SuDS would necessitate public engagement and private responsibility, with considerable risks that these systems would not be maintained. The distribution of the main benefits for the only option with a positive net present value (NPV) – SuDS in public places (option 3) – is shown in Figure 4. This figure reveals that, although the objective is to enhance water quality, the main benefits are for amenity and flood risk reduction. Most of the amenity benefit is reflected in property values that accrue mainly to the property owners. The technical guidance for Best (Ciria, 2016) explains how this benefit is valued from data obtained from ‘willingness-to-pay’ or ‘hedonic pricing’ studies, which model the impact on property or land values from enhancements to the local environment. There are also risks that there are overlaps between amenity as defined and valued in Best and other monetised benefits (especially recreation, biodiversity or water quality), and the guidance stresses the need to avoid double counting in this context (see also Ossa-Moreno *et al.*, 2017).

Option 3 has a positive NPV, but the relative costs are some 2.5 times those of the conventional solution (option 1). This leaves decision makers with a difficult choice – to spend significantly more money to get additional benefits for society as a whole or to spend the minimum and achieve regulatory compliance, but not maximise the overall benefit to society.

Comparisons of the two options considered for the Killingworth and Long Benton case study (Table 2) are shown in Figure 5 for BaU. Both options demonstrate a significant positive net benefit over the client-defined 2017–2117 timescale

Figure 4. Distribution of benefits for SuDS option 3 for Roundhay Park BaU

Figure 5. Overall benefit results for the Killingworth and Long Benton case study obtained using Best

of analysis. Table 3 shows a breakdown of the main benefits for option 1. In this case, the main benefits arise due to flood risk reduction with lesser value from water quality improvements and recreation. There is no large increase in amenity benefits, as was found in the Roundhay Park case. This is because the portfolio of SuDS for Killingworth and Long Benton does not add to the amenity as development is on land where there are already blue and green spaces.

Best and Teeb were both used to estimate the benefits of a proposed BGI retrofit scheme in the city of Dordrecht. The plan for the retrofit scheme is to open up the centre of the neighbourhood for blue and green space (Table 2). The breakdown of the main benefits assessed using Best and Teeb (discounted over 30 years) is given in Table 4 for BaU. The relative distribution of benefits is similar for both the Best and Teeb tools, despite the benefit categories differing and albeit with overlaps. In both tools, the dominant benefits relate to amenity because the properties involved will be overlooking a local park instead of a busy road. Each tool also assigns value to health benefits as the next greatest impact. Although the tools are not directly comparable (Esquivel Gómez, 2016), these results indicate similarities in the assignment and distribution of benefits in the Dordrecht case study.

Table 3. Distribution of the main benefits for Killingworth and Long Benton option 1 determined using Best

Benefit	Value: £
Flood risk reduction	49 835 955
Water quality improvements	1 435 055
Recreation	312 375
Amenity	100 292
Education	65 943
Biodiversity and ecology	38 956

Table 4. Results for Dordrecht retrofit of SuDS from use of Best and Teeb valuation tools

Benefit category	Tool	Value: €	Proportion of total benefit: %
Amenity	Best	9 853 440	77
Price of properties	Teeb	10 706 211	94
Health	Best	3 041 908	22
Health	Teeb	221 923	2
Air quality	Best	41 868	<1
Energy	Teeb	189 745	2

So far, only the traditional BaU scenario (i.e. today's situation plus one future projection) has been considered for each case study. The next section outlines the approach used in Best to include alternative futures using scenario planning.

3.2 Looking to the future

There is no definitive prediction of what the future needs, challenges or opportunities might be for the proposed options to address, despite the BaU assumptions above. There is thus significant uncertainty about the future performance and effectiveness of schemes designed today. A robust option is one that is less sensitive to the possible changes that may come about over time (Casal-Campos *et al.*, 2015). Next to aspiring for robustness, uncertainty about the future may require the system/option to be adapted or modified over time; therefore flexibility is an aspirational system characteristic. Best utilises the modified Cofas tool (Eckart *et al.*, 2012) to estimate the relative distribution of benefits from SuDS as a surrogate for flexibility as an indication of the relative distribution of benefits for each option and therefore their potential for providing benefits under possible futures (Ciria, 2016). This method provides a score to indicate the distribution of the various benefits for an option. A five-band scale is used (band A, 81–100%; B, 61–80%; C, 41–60%; D, 21–60% and E, 0–20%). In this scale, 100% is where there are a number of benefits, each of similar magnitude; an option with only one significant benefit accrues a score of 0%. Scores between 0 and 100% show that there are various benefits, but the benefits differ in magnitude.

The third edition of Best (Ciria, 2016) also includes scenario planning (Maier *et al.*, 2016) to help users consider the performance of options under plausible futures rather than the single future assumed in the BaU analysis. This corresponds with the standard Environment Agency approach used for flood and coastal erosion risk management planning (Brisley *et al.*, 2015). In Best, a three-step approach determines the relative robustness of the various options. Robustness provides the decision maker with information as to the likelihood of the option functioning in the future, whatever that future may look like. Step 1 is the BaU described in Section 3.1. In step 2 there are three optional levels of analysis to ensure

proportionality of analysis depending upon the scale of the development. These levels are

- level 1, for small-scale SuDS and initial screening of larger developments
- level 2, for intermediate-scale SuDS
- level 3, for the largest scale and most complex of SuDS schemes.

In step 2, the level 1 analysis screens out the least robust options and is therefore always worth undertaking to reduce the number of options considered in detail in level 2 or level 3 analysis. The analysis utilises up to four socio-economic scenarios as explained below. In step 3, the results are reviewed for decision-making.

Scenario analysis was undertaken for both the Roundhay Park and Killingworth and Long Benton case studies. Scenario analysis has not yet been undertaken for the Dordrecht scheme. Four scenarios were used in the UK case studies (see the Supplementary Material to this paper for further details). These scenarios are world markets (WM), national enterprise (NE), global sustainability (GS) and local stewardship (LS), defined in the Foresight programme together with climate predictions (UKCIP, 2000). Following a definition of the important drivers, impacts and potential consequences for each scenario by the stakeholder group (Table 5), these were used to assess the robustness qualitatively of all options against each scenario. In Best, a value of 1 is assigned to an option considered robust under a particular scenario and time epoch, and a value of 0 is assigned where the option is not considered robust; half scores are also possible where there is less certainty. Hence, where there are four scenarios, each option may score between 0 and 4, with increments of 0.5.

In the Roundhay Park case, option 1 (CSO tanks) scored 1.5 and option 3 (SuDS in public areas) scored 3.5. The level 2 simple method was applied as this requires no additional re-runs of the physical models (that create inputs for Best), unlike a level 3 analysis. An analysis of flexibility showed that option 1 scored as band E, whereas option 3 scored up to a maximum of band D depending on the scenario and the time period (epoch) considered. The stakeholder group defined these epochs as periods over which the SuDS would function without major interventions: 2015–2030, 2015–2055 and 2015–2095. Only option 3 (SuDS in public areas) was considered in the further analysis.

Figure 6 shows the distribution of the main monetary benefits for SuDS option 3 for Roundhay Park for the three consecutive epochs determined using Best and applying user-defined weighting scores (0, 25, ..., 175, 200%) to the individual benefits determined under BaU for each scenario and for each epoch. Between 2015 and 2030 the rate of change was modest and hence scenario analysis was not considered (Figure 6(a)).

Table 5. Examples of drivers and consequences under the four socio-economic scenarios for Roundhay Park case study 40 years after construction (2055) (this analysis was undertaken prior to the vote to leave the EU)

Driver	Consequences			
	WM scenario (high climate change)	NE scenario (medium climate change)	GS scenario (low climate change)	LS scenario (low–medium climate change)
National planning requirements; green infrastructure strategy and so on	Relaxed regulations, mix of land use types, less local industry	Highly regulated planning, but environment less important; no longer in EU; local (national) regulations	Strong controls, denser communities	Low (national), high local; simpler lifestyles and lower costs; leave EU
Government priorities	Economic growth	Government specifying regulations, not the EU	Strong controls to sustain planet. Circular and sustainable approach	More decentralised (e.g. devolved Yorkshire). London less important
Regulation in water sector	Relaxed regulations, mix of land use types, less local industry	Less international, more national regulation; leave EU	Strong regulation, possible nationalisation of industry	Leave EU, but locally decided with local services
Rainfall–runoff–urban growth, more surface water	High climate change and rainfall – only richest in society properly protected	More catchment management planning and maintenance of sewers	Reduced flooding with lower impacts – adapt and mitigate	Wide and varied range – overall society more resilient
Expectations and behaviours	High expectations in wealthiest areas	High among public, but expect government to pay. Low taxes	Expect high standards with government control. Circular economy	Less ownership of goods; lower aspirations and more willingness to behave responsibly

There are four significant benefits, with amenity being the greatest (as in the BaU case). From 2030 to 2055 (Figure 6(b)) and 2055 to 2095 (Figure 6(c)), flood risk reduction and other benefits dominate but the distribution is different for each scenario. The benefits were determined by weightings based on stakeholder scoring (detailed earlier) as to how the values may change after 2030 and up to 2055 and then from 2055 to 2095. For example, in each case the relative value of the benefits from flood risk reduction were sustained and weightings of 100% (i.e. the same as under BaU) were given under each scenario and for each time period, whereas recreational benefits were weighted as increasing in value (125%) only for the LS scenario for 2030–2050; for 2055–2095, they were weighted (compared with BaU) as 150% (WM), 50% (NE), 100% (GS) and 150% (LS). In both the robustness analysis and the weighting processes, subjective allocations of scores were made by the stakeholders in discussion. Therefore, these may not give precise results and there remain significant uncertainties that could be considered further in a sensitivity analysis. However, this is only recommended for the more detailed level 3 scale of a project.

Flood risk reduction remains the most significant benefit provided for the two time periods beyond 2030 and for each scenario. The uniformity of the value of the flood risk reduction benefits across all scenarios shows that these benefits are likely to be robust whatever the future. The amenity benefits cease from the second period for all scenarios because of the one-off nature of the property value increase. This corresponds with the findings of Zhou *et al.* (2013) regarding increased property

values from BGI levelling off over time. From this analysis, SuDS in public areas (option 3) was found to be the more robust and the most flexible (most uniform distribution of benefits) option and to provide a range of individual benefits, as well as the primary objective of water quality improvement, that are sustained (apart from the amenity benefits) over the three epochs considered.

Overall, the BaU analysis determined the total benefits to be £11.1 million for SuDS in public areas (option 3). Summing the values for the three time epochs in Figures 6(a)–6(c), the present values of the benefits using a UK government discount rate of 3.5% were found to be £10.6 million, £10.0 million, £9.4 million and £10.8 million for WM, NE, GS and LS scenarios, respectively. A small reduction in benefit value over time was found for each scenario, but this is not significant in terms of the overall uncertainty in the analysis. The distribution of benefits for each scenario varies for each epoch but never scores higher than band D, a relatively poor distribution of benefits in the longer term. This is because a single benefit (flood risk reduction) dominates the overall value.

A Best scenario analysis for Killingworth and Long Benton used the level 2 analysis to determine the way in which the benefits for option 1 may change over time (Figure 7). This shows how the benefits change between scenarios and for the stakeholder-defined three sequential time epochs considered. In each case the dominant benefit was from flood risk reduction, which remained the most significant benefit over time and in each of the scenarios. The changes in value for the

Figure 6. Benefits of option 3 for Roundhay Park determined using Best for three epochs under four scenarios: (a) 2015–2030; (b) 2030–2055; (c) 2055–2095

Figure 7. Best scenario analysis results for Killingworth and Long Benton for three time epochs (2017–2040, 2041–2080 and 2081–2117) and for the four scenarios used in Figure 6

second and third epochs used the scaling of the benefits from stakeholder-assigned weightings in the same way as for the Roundhay Park case study. In each scenario, the distribution of benefits scored was in the lowest category (band E). This is because the benefits are dominated by flood risk reduction, the primary objective of the scheme; hence option 1 lacks flexibility but provides the required performance.

Further or more detailed scenario analysis can be carried out by re-running the physical models for the proposed options in each case study (i.e. a level 3 analysis above). These runs would need to utilise the changes to systems, drivers and future conditions defined by the scenarios and for each epoch. It is recommended that this be done only for larger or more significant schemes due to the cost of such analysis.

The final step 3 of the analysis is where the outcomes are reviewed and the preferred option is selected. This decision is informed by all of the results from the analyses conducted.

The case study analyses have illustrated how, despite each case having a primary objective, each scheme where SuDS are used can deliver a number of other benefits, in some cases of greater magnitude than those provided by the primary objective. The SuDS option for Roundhay Park, with water quality improvements as the main objective, in fact delivers greater benefits from amenity and flood risk reduction, whereas the Killingworth and Long Benton SuDS option, which aims at flood risk reduction, does deliver the greatest benefits for this. In Dordrecht, the primary objective is regeneration to improve liveability. However, the greatest benefits identified using both Best and Teeb were property values (amenity) and health.

3.3 Leveraging value

Throughout the analysis process outlined in the previous sections, ways in which added value from the SuDS options can

be obtained should be considered, including who the stakeholders are now and who they may be in the future and whether or not added benefits can be achieved by making relatively minor additional investments. Adding significant value from marginal investments is termed 'leveraging' (Abson *et al.*, 2016) in Best analysis, and this is illustrated for the Roundhay Park case study in the Supplementary Material to this paper. This shows that, by increasing the numbers of trees from the original 250 to 1000, the number of people with a view over green spaces increases from 125 to 500 and the health benefits rise from £0.6 million to some £3.3 million for a limited additional cost of around £0.25 million.

4. The challenges of taking advantage of the benefits on offer

Given that society is the main recipient of the multiple benefits, how do the current arrangements for surface water management in England and Wales (Ellis and Lundy, 2016) encourage or inhibit the delivery of SuDS benefits and how might this be improved? Ellis and Lundy (2016) show that if the multiple benefits from SuDS are to be fully realised there are considerable complexities in trying to work across the numerous interested parties and sectors, many of whom overlap in jurisdictions.

In Philadelphia, the mayor has jurisdiction over all of the major services of the city. The mayor's purview includes all of the benefits addressed in Best and more. The tool developed by CNT (2010) has been used to show that the overall value of using SuDS to manage 50% of the CSO spills in Philadelphia is some \$2.6 billion, compared with only about \$100 million in benefits from using below-ground storage chambers (Stratus Consulting, 2009). These benefits accrue to and are seen as valuable by the people of Philadelphia. There is, however, a marked contrast between the situation in Philadelphia and the equivalent jurisdictions and responsibilities in England and Wales.

There are also issues as to who benefits and who pays for the individual benefits, many of which are specific to context or the case under consideration. In England, the water and sewerage companies, alongside local authorities and the Environment Agency, have drainage responsibilities. Bringing these together in a way that maximises opportunities (e.g. *21st Century Drainage Programme* (Water UK, 2016)) is not an easy task. Each stakeholder group has specific statutory duties and is constrained as to how these can be fulfilled. Certain stakeholder groups often fail to see the connections between one set of duties and another, such as the revised health duties placed on local authorities by the Department of Health (DoH, 2011). Despite clear evidence of BGI bringing major health benefits (Kirby and Russell, 2015) (see Section 3.3), few local authorities or health authorities engage in what is seen as the 'drainage' domain to take advantage of the wider benefits on offer.

A further case study considered the wider benefits SuDS uptake could bring to London. Ossa-Moreno *et al.* (2017) used Best to demonstrate the significant added benefits to both householders and the local authority. There are a number of other beneficiaries, including major infrastructure providers for electricity, roads and the London Underground, although the benefits to wider society were rated low, at only around 1%. However, these results only reflect the SuDS options investigated. Alternatives would accrue other benefits and include other beneficiaries.

There is increasing interest in urban planning for and with multi-functional infrastructure and the role that SuDS can play in facilitating this (e.g. Hansen and Pauliet, 2014). SuDS need to play a major part in realising what can be achieved through these urban planning processes, especially in local area development plans. In England, the primary planning instrument is the National Planning Policy Framework (DCLG, 2012), which mentions SuDS as part of the objective to ensure 'sustainable development'. Lack of commencement of Schedule 3 of the Flood & Water Management Act 2010, which relates to SuDS, is a significant limitation in the promotion of the use of SuDS. Because of this, the Chartered Institution of Water and Environmental Management concluded that policy constraints are the major block to SuDS uptake in England through weak planning policy, resource limitations of local authorities, a lack of clarity regarding adoption and weak standards leading to poor quality schemes (Ciwem, 2017).

In contrast to the situation in England, in Wales, the Well-being of Future Generations (Wales) Act 2015 (Welsh Government, 2015) is intended to make the public bodies listed in the Act think more about the long term, work better with people and communities and each other and to take a more joined-up approach. In delivery, public service boards have been established who will have significant opportunities to take an overview of SuDS and their associated benefits, ensuring that these are secured to the maximum benefit of the people of Wales.

5. Conclusions

The development of tools such as Best has provided the means to estimate the financial benefits provided from the use of SuDS. The case studies presented in this paper show how Best can help to provide insights into the overall and individual benefits from SuDS, often as a by-product of the primary requirements of the decision maker. In two of the three case studies presented, the main by-product is elevated property prices, despite other benefits being aimed for as the primary objective. As such benefits accrue to property owners and developers, this raises the question as to who should pay for such benefits.

The case studies show that there is a need for planners of SuDS to look beyond BaU analysis where today's situation is

used for design, together with uplifts to rainfall and urbanisation, to include scenario planning to test option robustness and also evaluate the way in which benefits may change over the lifetime of a scheme. This ensures that the expected service can continue to be provided whatever happens in the future.

The other main benefit found in two of the case studies is the wider value of green SuDS to human health (Section 3.3). Although health is a major aim of many of the institutional players engaged with water and urban place-making, it is still rare to find cases where these players are actively investing in making better places to live, which includes SuDS, thus improving health via changing living conditions instead of dealing only with the symptoms of illness (Kirby and Russell, 2015).

Concerted effort will be required from all parties with an interest in water, drainage and other domains that benefit from SuDS in order to take advantage of the valued benefits SuDS can provide. In many countries, the funders and beneficiaries are clear, but less so in others. Matching opportunities to infrastructure providers is a great challenge and probably the greatest uncertainty for the security of future service provision (Lawson et al., 2015). It is time to raise questions about the way in which our society structures the provision of essential services around water systems.

If the current market failure from not utilising SuDS (Ciwem, 2017) is to be addressed there needs to be greater understanding among the whole range of infrastructure and service providers of the opportunities SuDS can provide. This requires education, leadership from professional institutions (e.g. Ciwem, 2017) and a willingness to engage with property owners, dwellers and all strata of society to move on from drainage as ‘a problem’ to ‘it’s not drainage – it’s an opportunity’.

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